CURRENT LITERATURE

BOOK REVIEWS

Iron bacteria[1]

Coming from such authoritative source, this monograph ought to command the earnest attention of workers in the fields of science and of hydraulic and sanitary engineering; containing as it does so much that is of both scientific and practical interest, and embodying within its compass facts and deductions derived from the fruitful though laborious work of some eighteen years. The book is divided into seven chapters with the following titles: (1) The presence and distribution of the iron bacteria; (2) New iron bacteria, and a systematic review of known forms; (3) Pure culture methods; (4) The physiology of iron bacteria, and WINOWGRADSKY'S hypothesis; (5) Other iron organisms; (6) Iron bacteria in relation to the production of bog iron ores; (7) The iron bacteria in their relation to practice: (*a*) rust formation in water pipes, (*b*) iron bacteria and the therapeutic use of chalybeate waters. In this review it will be possible to touch only upon the salient features of the treatise.

The author calls attention to the very wide distribution of the several species of iron bacteria, such as *Leptothrix ochracea*, *Cladothrix dichotoma*, *Crenothrix polyspora*, *Clonothrix fusca*, and *Gallionella ferruginea*, which occur in most bogs, ochre deposits, chalybeate springs, and stagnant waters, and at times in iron water pipes. As is well known, their presence in water pipes may create a veritable nuisance by the plugging of the pipes, or by rendering unfit for manufacturing purposes water that ought to be perfectly clear. It is pointed out as noteworthy that so far no iron bacteria have been recognized growing in sea water. To the six already well known species of iron bacteria, MOLISCH has added three others: *Chlamydothrix sideropus*, *Siderocapsa major*, and *Siderocapsa Treubii*, the last, curiously enough, being found growing on the submerged portions of certain aquatic plants, for example, *Elodea canadensis*, *Vallisneria spiralis*, and *Salvinia auriculata*. Doubtful recognition is extended by the author to certain new forms described by DAVID ELLIS. To obtain pure cultures of the various forms it is recommended that manganese peptone be used in combination with the native water and gelatin or agar, and the cultures should be grown at or about 25° C.

Considerable space is given to a discussion of the physiology of the iron bacteria, dealing particularly with the older and widely accepted theory of

[1] MOLISCH, HANS, Die Eisenbakterien. pp. vi+83. *col. pls. 3. figs. 12.* Jena: Gustav Fischer. 1910. *M* 5.

WINOGRADSKY that considers iron as a definite necessity for the carrying on of the vital processes of the bacteria. MOLISCH criticizes WINOGRADSKY'S work upon the grounds that that investigator did not work with pure cultures, and chose a bacterium (*Cladothrix dichotoma*) which did not actively store up iron as does one of the commoner forms (*Leptothrix ochracea*), so that his chances for accurate observation and deduction were sadly impaired. On the other hand, MOLISCH has worked with these organisms in pure culture, has demonstrated that they can grow readily enough on an iron-free medium, and that on examination of their protoplasm by microchemical methods no iron can be found. Further, he has shown that the iron bacteria can make use of manganese, as it occurs in water, in a similar way in which they use iron. According to the author, the iron in solution in the water is simply *deposited* in the viscid sheaths of the bacterial filaments in the form of soluble carbonate of iron, and through the action of the atmospheric oxygen it becomes altered to ferric oxid. This ferric oxid is in no discernible way utilized by the bacteria in their vital processes, but in its insoluble state acts as a protecting armor to the delicate protoplasmic filaments, pretty much in the same way as do the deposits or accumulations of silica in the case of the diatoms, or in the case of the epidermal cells of the grasses. When the bacteria use manganese, it is believed that that element is laid down in the sheaths in the form of manganese hydroxid, which under the action of the oxygen of the air is probably altered to manganic acid and finally to manganite.

The disappearance of the bacteria from waters that have been subjected to certain forms of treatment in which the iron is removed, MOLISCH explains in this way. Whether the form of treatment is that of filtration through sand or coke, or by chemical methods, great quantities of soluble organic materials in combination with hydrogen sulfid, ammonia, or carbonic acid are coincidentally removed, and this loss of organic materials is the real element determining the vanishing of the bacteria, inasmuch as it means the utter deprivation of the food supply, the absence of the iron being a matter of entire indifference. In the case of bog waters, the food supply is in the form of humus organic matters that are very readily removed by any method that removes iron. There exist in nature, MOLISCH states, other organisms than bacteria that are capable of fixing iron. These organisms are to be found among the algae, flagellates, and infusoria. His student ADLER has also demonstrated that some of them are able to fix manganese as well as iron. In all cases the *modus operandi* is quite similar to that of the bacteria.

Discussing the nature of the formation of deposits of ochre and bog iron, the author takes no dogmatic stand, but weighs the evidence in the light of the presence or absence of bacteria in material taken from such sources. The finding of bacteria in such deposits argues much for them playing at least a partial rôle in the formation, although it cannot be overlooked that there must be also a chemico-physical precipitation of insoluble iron due to the action of

the atmospheric oxygen and to the alkalescence of bog waters by aquatic plants. In rare instances the iron deposits may be made up almost entirely of the sheaths of the filamentous iron bacteria *Gallionella ferruginea* and *Leptothrix ochracea*. It may also be possible that deposits in which no bacteria may be found may have had their start by the growth of iron bacteria, but later on these may have died out and left no trace of their presence.

In regard to the formation of iron rust in water pipes, the author is in accord with the observations of the English investigator BROWN, and others, who believe that very often the incrustations of rust on the inner surface of the pipes may begin in areas accidentally left bare in the usual tarring process, and ferric oxid is formed by the action of the water entirely apart from the presence of iron bacteria, as the author himself has time and again demonstrated. It must be remembered, however, that where the presence of iron bacteria can be unequivocally established, there must occur the favorable combination of both soluble iron and organic food material; lacking the latter in sufficient quantity, no iron bacteria can gain a foothold.

MOLISCH very timely points out that much of the chalybeate waters bottled for medicinal purposes is worthless on account of the precipitation of the iron in insoluble form (ferric hydrate). This may be caused in one of two ways: (1) by the action of the air acting on the soluble iron carbonate, and (2) by the activities of one or other of the iron bacteria. This latter fact is established beyond a doubt, inasmuch as ADLER has cultivated iron bacteria from the waters of several chalybeate springs, and by the addition of various antiseptics has delayed the action of precipitation of the iron by inhibiting the growth of the bacteria. In practice such waters are recommended to be treated by filtration or by sterilization by heat.

The monograph is supplied with a full bibliography of the subject, and is plentifully illustrated with colored plates, original drawings, and photographs. The work constitutes a most valuable contribution to our knowledge of these peculiar and interesting microorganisms.—NORMAN MACL. HARRIS.

The morphology of gymnosperms[2]

In the present handsome volume the authors have more than doubled the size of their book on the same subject published almost a decade ago. It is a significant fact that the "fossil gymnosperms," relegated to an all too brief chapter in the earlier edition, are now distributed in accordance with their evolutionary sequence, and adequately and even copiously treated. The volume begins with the Cycadofilicales, as they are appropriately dubbed, in preference to the earlier and less suitable appelations Cycadofilices and Pteridospermeae. This group of gymnosperms, which has clearly emerged

[2] COULTER, J. M., and CHAMBERLAIN, C. J., Morphology of gymnosperms. pp. xi+458. *figs. 462*. Chicago: The University of Chicago Press. 1910. $4.10, postpaid.